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Abstract

Do political variables influence long-term environmental transitions? The discussion on the determinants of the environmental performance of countries has been dominated by a focus on the Environmental Kuznets curve. This concept concentrated primarily on the role of economic factors, in particular per capita income levels. By contrast, we outline both conceptually and empirically how political factors can affect long-term carbon trajectories. Our findings from an error-correction model suggest that political factors are an important explanatory variable for carbon emissions in over 100 countries during the period 1970-2004. The results show that political capacity reduces carbon emission in OECD countries whereas political constraints, democracy and the Kyoto Protocol reduce long-term carbon emission in the group of all countries as well as in non-OECD countries.

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1. Political or Economic Determinants?

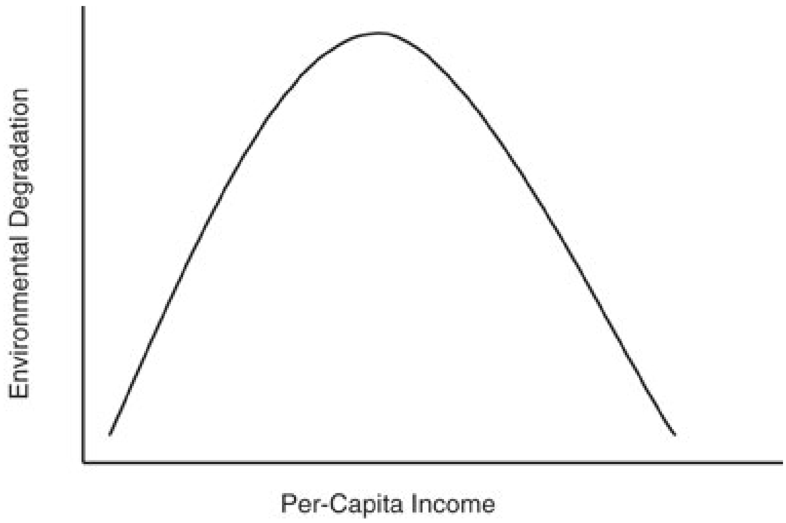
Can countries successfully achieve long-term environmental transitions, in terms of fundamental rather than marginal change (Sprinz forthcoming)? The concept of the Environmental Kuznets Curve (EKC) suggests that comparatively high levels of economic development enable such transitions. By contrast, we argue that benign environmental trajectories depend on a range of political factors such the political capacity of governments, democracy, as well as the political constraints placed on policy change.

In the mid-1990s, the literature in economics suggested that environmental conditions across countries depend on per capita income levels. In particular, an inverted-U shaped trajectory for the relationship between per capita income and per capita emission was suggested. The perhaps clearest description of the argument is offered by Dasgupta et al. (see Figure 1):

> In the first stage of industrialization, pollution in the environmental Kuznets curve world grows rapidly because people are more interested in jobs and income than clean air and water, communities are too poor to pay for abatement, and environmental regulation is correspondingly weak. The balance shifts as income rises. Leading industrial sectors become cleaner, people value the environment more highly, and regulatory institutions become more effective. Along the curve, pollution levels off in the middle-income range and then falls toward pre-industrial levels in wealthy societies (Dasgupta et al. 2002, 147).

Assuming some learning or technological diffusion, relative latecomers may purse a somewhat more benign pollution path.

<u>Figure 1:</u> Stylized Environmental Kuznets Curve



Source: Hayward 2005

The empirical debate about the existence of an inverted U-shaped relationship did not lead to clear results, hinting at initial model misspecification. Countries may follow quite different trajectories even at comparable levels of economic development, and the trajectories may also vary by pollutant.

Given the current discussion about the long-term effects of climate change which are likely to involve considerable non-reversible impacts, the question arises whether a transition to a low-carbon economy can be achieved (European Environment Agency 2005). If such a goal is desirable, it would be important to learn whether political factors can make such an outcome more likely. While we cannot easily predict what the future will bring, we can assess whether political factors help us to explain *past* pollution trajectories. The answer to this question is of relevance to both academia and policymakers. Earlier studies tended to omit political factors in the explanation of pollution trajectories. By including such variables, we explore the enduring effect of politics on pollution trajectories.

The paper is structured as follows. Section 2 reviews the debate on the EKC whereas Section 3 highlights the relevant political determinants of long-term environmental transitions. In Section 4, we present our results of the political and economic determinants of carbon trajectories. The final section concludes with a brief outlook on the research ahead of us.

2. The Environmental Kuznets Curve

The question of the influence of levels of economic development on environmental conditions across countries achieved prominence on the scientific agenda in the context of the development of the North American Free Trade Agreement (NAFTA) and associated concerns about its environmental impact. Arguing that further economic growth would help Mexico improve its environmental record, Grossman and Krueger (1995) claimed that NAFTA would be environmentally beneficial. They based this argument on their statistical finding of an inverted U-shaped relationship between levels of economic development and environmental degradation.

Grossman and Krueger's findings stood in stark contrast to traditional concerns about the impact of economic growth on environmental performance, e.g. the findings of the Club of Rome in the 1970s. Typically, these approaches had conceived environmental degradation to uniformly increase with growth, at least until overuse of environmental resources leads to negative feedbacks. Furthermore, Grossman and Krueger's findings were politically convenient as they implied that countries could simply "grow" out of their environmental problems.

Two decades of research on the relationship between levels of economic development and environmental performance, however, reveal that a range of possible relationships exists: linearly increasing or decreasing trends, inverted

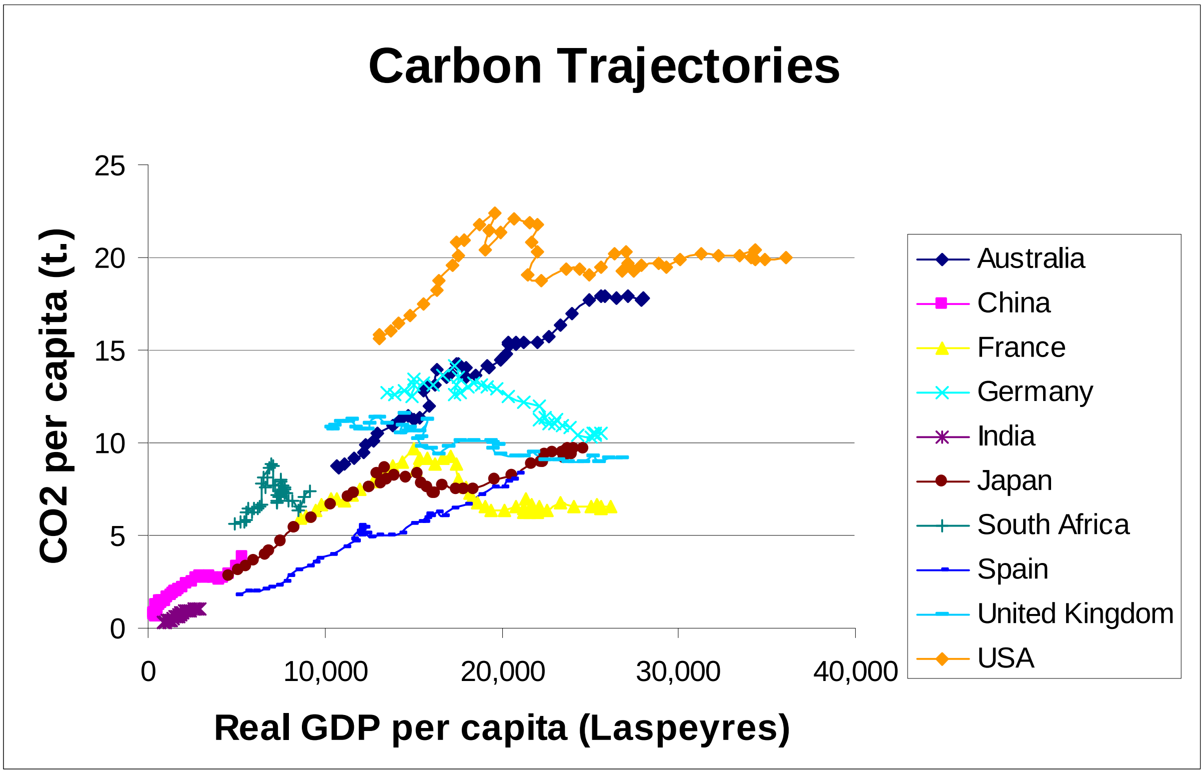
U-shaped trajectories, as well as N-shaped relationships.[1] Moreover, scholars have shown findings to be highly dependent on the environmental indicators and control variables chosen, as well as the data and statistical methods employed (Fuchs 2003; Lempert et al. forthcoming; Stern 2004). Overall, the existence of the EKC has become highly controversial.

More comprehensive explanations of the relationship between per capita income levels and environmental quality are largely missing. As Fuchs (2003) has shown there is no one to one relationship between changes in par capita income levels and environmental quality, as other factors strongly influence environmental quality at a given level of economic development. At the same time, there is no scientific consensus on the political (and economic) factors that ought to be included in econometric models besides per capita income levels (Dasgupta et al. 2002; Yandle et al. 2004).

With respect to the specific focus on carbon emissions, the situation is similar. The existence of an EKC is controversial and comprehensive analyses of the determinants of the carbon trajectories of countries are missing. There is only a slight majority of studies supporting the hypothesis of an inverted U-shaped trajectory for carbon dioxide, in particular for OECD countries (Galeotti et al. May 2006; Martínez-Zarzoso et al. 2007). In fact, a bivariate plot of the trajectories of select large carbon emitters reveals considerable variation between countries (see Figure 2). At the same time, most studies only analyze the impact of per capita income on emissions and fail to pay sufficient attention to political variables (Galeotti et al. May 2006; Huanga et al. 2008; Roberts and Grimes 1997). In consequence, substantial ambiguity over the influence of the political characteristics of countries and time effects caused by specific political events, for example, remains.

[1] An N-shaped relationship indicates a relinking of economic growth and environmental pollution at higher income levels and was found by De Bruyn and Opschoor 1997, for instance.

Figure 2: Per Capita Carbon Trajectories (1960-2004) (selected countries)



Sources: see Appendix.

One would expect politics to have an influence on the environmental performance of a country, however, irrespective of its level of economic development. After all, reducing environmental degradation requires the overcoming of collective action failures, which in turn depends on political will and capacity. Dasgupta's quote in the introduction is revealing: both the willingness of people to have a cleaner environment and the efficiency of regulations and institutions are political issues. In consequence, the influence of political factors on carbon emissions at any given level of development needs to be investigated.

In conclusion, scholars tend to agree that per capita income levels have a substantial impact on environmental degradation in general, and carbon emissions, in particular. The functional form of the relationship is highly controversial, however, and the predominance of an EKC more than ever in doubt. Our research hints at a possible reason for this: the influence of political factors, which is as yet unclear and requires urgent inquiry.

3. Political Factors

In this paper, we aim to highlight the role national and international politics plays in determining long-term carbon trajectories. On the side of national political characteristics, we consider three factors: a) the political capacity of governments, b) political constraints, and c) the level of democracy. These three factors occupy a prominent place in scholarship on country performance with respect to different policy issues, in general, and environmental policy, in particular.[2] As we argue below, they are also important factors for our inquiry on the cross-national and cross-temporal determinants of environmental trajectories. On the side of international political developments, we consider two major stages of global climate change governance: a) the Framework Convention on Climate Change (FCCC) and b) the Kyoto Protocol. Both treaties have dominated the agenda of global climate change politics and a country's signature status should signal its attention to the issue of carbon emissions.

First, some scholars have suggested that the political capacity of a government provides a powerful explanation of political outcomes (Organski and Kugler 1980; Arbetman and Kugler 1997). They based this claim on the observation that some governments perform better in achieving a given political objective than others, irrespective of the institutional structure in which they act. In this vein, Jänicke and Mönch (1988) argue that the ability of a political system to react to problems and its capacity to pursue goals in a coordinated manner

[2] e.g. Arbetman and Kugler 1997; Feng 2005; Fuchs 2003; Henisz and Zelner 2006; Henisz et al. 2005; Midlarsky 1998; Knill et al. 2008.

over long periods of time is likely to be a crucial determinant of environmental outcomes.

But how can one capture the political capacity of governments? Organski and Kugler (1980) and later Arbetman and Kugler (1997) have argued that it is reflected in the ability of governments to extract resources from their population, which signals the extent to which a government is popularly endorsed or accepted (see also Arbetman-Rabinowitz and Johnson 2007):

> Governments all require resources in order to enact policies. Taxation represents willingness on the part of the population (or enforcement ability on the part of the government) to transfer resources from private individuals to the government. This resource transfer is the bridge between politics and money; taxation demonstrates an endorsement or at least acceptance of a government by the population. … A measure based on extractive capabilities of a government allows for an assessment of the efficiency and performance of a government (in relation to its expected performance) that does not reflect resource allocation and is not tied to institutional design (Arbetman-Rabinowitz and Johnson 2007, 4).

Accordingly, they operationalize relative political capacity in terms of the actual ability of governments to extract resources relative to their estimated potential for extraction (controlling for factors that are not in the hands of governments, such as resource endowments). Efficient governments are expected to make full use of their extractive capabilities, while inefficient governments are expected to fall short on this. The indicator has been applied to a variety of research contexts, including economic outcomes, such as inflation and investment, and political outcomes, such as war and internal political violence (Arbetman-Rabinowitz and Johnson 2007).

In the context of our research question, we expect the political capacity of governments to allow them to pursue environmental policy objectives with greater effectiveness. Likewise, we imagine highly capable governments to be better able to create the institutional and material infrastructures supporting the energy efficiency of their economy. Similarly, "capable" states will be better at enforcing property rights and limiting negative externalities, i.e. at reducing collective action problems and forcing individuals and firms to internalise the costs of pollution. In the period we are considering, this situation is more likely to have existed for OECD countries than for developing countries. The former had to pay attention to environmental issues since the 1960s and 1970s, due to rising environmental movements as well as the arrival of environmental politics on the global agenda in the context of the Stockholm conference in 1972. In contrast, economic growth dominated the political agenda for developing countries, especially as an image of a trade-off between economic and environmental objectives prevailed in this era. This leads us to hypothesize that higher political capacity is negatively related to environmental degradation, in particular in OECD countries.

Second, scholars have suggested that trust in the probability of policy reversal will have an effect on economic and political outcomes in situations in which substantial investments by actors are needed. Specifically, Henisz (2000) has argued that business actors are more likely to invest in telecommunications or energy related infrastructure in countries in which the risk of a reversal of liberalization and deregulation policies inviting such investments is low. This situation applies in our context as well. The potential of substantial reductions in per capita carbon emissions ultimately rests on substantial changes in production and/or consumption processes and structures in a country. Who will invest in such changes in the absence of trust in the stability of the underlying policies?

In order to assess the risk of policy reversals, Henisz (2000) has developed an indicator of political constraints. This indicator measures the feasibility of policy change given the number of veto points and the preference alignment of the relevant actors in a political system. Henisz aims to improve on previous measures of political risk, which failed to comprehensively consider both the institutional set-up and the potential for preference heterogeneity between the political actors with veto power. In operational terms, Henisz' political constraints index uses a spatial model of political interaction which yields a score ranging from zero (unconstrained) to one (most constrained) for a given political system.

In the context of our research question, the presence of veto players (i.e., higher level of political constraints) prevents the development of policies that involve large negative externalities. The more actors have to be satisfied by any decision, the less likely that projects with negative externalities would be launched.

Third, comparative studies of the determinants of environmental policy have focused on the role of the institutional structure of a political system in explaining cross-national differences in environmental quality. Scholars especially have considered the impact of regime type on environmental policy output and outcome (Payne 1995; Buell and DeLuca 1996; Midlarsky 1998; Press 1994; Williams and Matheny 1995). The direction of the influence of this factor is quite controversial, however. Some authors claim that democracies are incapable of solving major environmental problems, as the liberty awarded to self-interested individuals to pursue their personal gain may lead to negative externalities and engender collective action problems (Hardin 1968; Heilbroner 1975; Ophuls 1977). Other authors suggest that democracies are superior in solving environmental problems because of the higher degree of long-term legitimacy awarded to environmental policies, superior information flows, and –

where existing - a higher responsiveness to public demands for a clean environment (Press 1994; Passmore 1974; Payne 1995; Ward 2008).

We find this second perspective more convincing. In the context of our research question, we expect a greater degree of transparency in political, economic, and environmental activities, a higher level of public acceptance of environmental policies, and a greater responsiveness to public demands to facilitate the reduction of carbon emissions. We operationalize the level of democracy in a country by using the democracy index included in the Polity IV dataset by Marshall, Jaggers and Gurr. Like the previous versions, the current version Polity IV contains a composite indicator of levels of democracy in a given country combining characteristics such as the competitiveness and openness of executive recruitment, and the regulation and competitiveness of participation. Based on the above argument, we hypothesize that higher levels of democracy will lead to lower emissions.

Until now, we have only considered the influence of domestic political characteristics on a country's carbon trajectory. International politics, however, is likely to exert an influence as well, especially in the era of globalization and global governance. Global climate change politics, in particular, deserves attention here. The development of the FCCC in the context of the Rio summit and the Kyoto Protocol thereafter signalled that carbon emissions had arrived on the agenda of global environmental governance. The FCCC contained little concrete demands on its members, and the Kyoto Protocol only did so for OECD countries, of course. Moreover, these treaties have only been signed recently. Still, the agenda-setting effect of these treaties should not be underestimated. By signalling government commitment to domestic lawmakers, investors, and other countries, facilitating information exchange, and fostering technological cooperation, for instance these treaties are likely to be linked to a reduction in carbon emissions in all member countries.[3] In consequence, we hypothesize that countries which have signed the treaties will have lower emissions.[4]

4. Data Analysis & Discussion

We chose per capita carbon emissions as the *dependent variable* as it is a necessary condition for a transition to a low-carbon economy in the context of economic growth. It also plays an important role in terms of fairness considerations in the discussion on how to limit global GHG emissions.

For the purposes of our research, we have created a dataset from reputable sources which are listed in the Appendix. The political variables were made available by the developers of the particular indices, and the economic variables were derived from the Penn World Tables. The dependent variable, carbon emissions, has been extracted from the World Resource Institute's CAIT 6.0 database.

Our dataset comprises nearly all countries with proper statistical services over the time span 1960-2004, yet the service sector variable constrains us to the period 1970-2004. As countries have very divergent patterns of data availability and in view of our interest in long-term emissions, we restrict the analysis to countries with at least 20 years of complete observations. The analyses presented below refer to a total of 109 countries – omitting many economies in transition for reason of lacking sufficient data series. Of the countries included in the analysis, 23 countries are OECD members during the period under investigation, and 12 are OPEC countries.

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[3] See also the extensive literature on the effectiveness of international (environmental) regimes (e.g. Bernauer 1995; Downs et al. 1996; Hovi et al. 2003; Keohane et al. 1993; Mitchell 2002, Mitchell 2006; Stokke and Vidas 1996; Young 2001).

[4] Alternatively, one could have chosen ratification. However, we understand international treaties to have initially a signalling effect on both domestic lawmakers (who will write bills in their national assembly) and foreign countries, as well as on private investors. This effect can largely be captured by the signature of the treaty, rather than the ratification.

The political variables included in the analysis comprise domestic properties of political systems and the signature status of climate-relevant international treaties. More specifically, the three domestic political variables comprise relative political capacity, political constraints, and democracy (see previous section). Furthermore, the UNFCCC and its Kyoto Protocol have been created with the goal to limit GHG emissions.

Besides the political variables, we controlled for a range of economic variables. These include per capita income – the cornerstone of the EKC discussion – as well as international trade and a few other economic control variables (see below).

Exploratory analysis of the times-series cross-sectional data pointed to strong error autocorrelation and substantial heteroskedasticity. Our estimation employs panel-corrected standard errors (Beck and Katz 1995; Beck 2001). As comparatively small countries, which also often happened to be oil-producing countries, caused substantial outlier problems, we weighted countries by the natural logarithm of their population, and included OPEC membership status and interactions with related variables to account for their specific situation. All variables are summarized in Table 1.

To test our hypotheses, we estimate an Error Correction Model (ECM). Two reasons support our decision. First, early diagnosis tests indicated that some of our variables might cointegrate. Using traditional OLS or related regression techniques might then lead to spurious relationships. The ECM allows overcoming this issue.

Second, we are interested in both the short- and long-run relationships between our core variables and our dependent variable. The study of long-run trajectories requires to understand what influences per-capita carbon emissions in the present and in the more distant future. For this purpose, an ECM is the ideal tool to estimate both type of effects.

Technically, the functional form of an ECM is:

$$\Delta Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t-1} + \beta_3 \Delta X_{i,t} + \ldots + \varepsilon_{i,t}$$

where the direct, short-term, effects are captured by the coefficient of the first difference of the independent variables, while the long-term effects are assessed through the lagged independent variables (Franzese 2002). Importantly, this analysis estimates the first difference of per capita carbon emissions, not the level of these emissions, which is what our study is focused on (see Table 2). Hence, in order to understand the effects of our independent variables on the per capita level of carbon emissions in Table 2 (below), one needs to divide the coefficient β_n by $-\beta_1$ (i.e., the inverse of the coefficient of the lagged dependent variable). The transformations for a selection of independent variables are presented in Table 3. Notice that it is a simple linear transformation, and both the signs and the significance levels remain identical to those in Table 2.

The empirical analyses are presented below in Tables 2 (in differences) and Table 3 (in levels). Model (1) includes all countries; Models (2) and (3) look at two large subsets of all countries. Model (2) limits the observations to OECD members and Model (3) to non-OECD (i.e., developing) countries. Model (4) focuses on OPEC countries only. The rationale is to better discriminate among the very heterogeneous set of non-OECD states.[5] As the political constraints and democracy variables are highly correlated, we alternated their inclusion in each of the four analyses, with the (a) results including political constraints and (b) results incorporating the level of democracy respectively. Overall, the explanatory power of our model is limited for the group of all countries and increases to 10-19% for specific country groups.

[5] Obviously, variables that were region specific in Model (1) are dropped in models (2), (3), and (4).

Our original research question was whether political variables have persistent effects on emission trajectories – while accounting for economic variables. The answer is affirmative. For the purposes of ease of exposition, we will concentrate our discussion on the results in levels as listed in Table 3.

Let us first turn to the domestic political variables. Relative political capacity nearly always has a carbon-reducing impact. Only for the cases of the OECD countries does it have a very pronounced and statistically significant effect: ½ unit of increase in relative political capacity leads to emission reductions of about 3.75 t CO2 per capita.[6]

We alternated the inclusion of political constraint and democracy due to their high correlation. Again, each of these variables had normally an emission-reducing effect. Specifically, a 1/10 increase in political constraint leads to an decrease of emissions by .22 tons for non-OECD countries and a reduction of .52 tons of CO_2 for all countries. These results are, however, difficult to interpret substantively as the measure is used continuously across time and space. Perhaps there are different lock-in effects during the upwardly sloping part of the per capita emissions curve as compared to the downwardly sloping part of the same curve. The current results only report an average, and future research may be directed to elucidate whether two different types of political veto or lock-in effects may exist: a program for economic growth during the earlier stages of economic development vs. a program for environmental protection later on.

Democracies do indeed generate lower levels of per capita carbon emissions, ranging from a reduction of .07 t for non-OECD countries to a reduction of .18 t of per capita CO_2 for all countries on a 21-point scale. Since political systems

[6] This is a very substantial effect, yet should be seen in the context of the development of the measure: it is the relative extraction ratio as compared to other countries. For one country to improve, others have to lessen their political capacity (c.p.). The development of measures of absolute political capacity will remedy this caveat.

have changed their democracy values over the past half century markedly, the emission-reducing effect of democratic transitions cannot be underestimated.

We notice that the effect of democratic levels is only significant in non-OECD countries. One explanation for this is that is possible that there is a democratic threshold: once a country reaches a certain level of democratization, the effect of additional 'democracy' loses its effect. In other words, once a country becomes an established democracy, it does not matter in terms of carbon emissions whether it marginally improves its democratic institutions.

In addition to the domestic political variables, we focused on the effect of international climate treaties on the emission trajectory of countries. Given that the two climate treaties could only have effects towards the end of our time series, we originally expected mild, yet emission-reducing, effects. While the UNFCCC generally has no effect – except for a statistically significant emissions-increasing (!) effect in OPEC countries – the Kyoto Protocol witnessed clear emission-reducing effects. In particular, in the group of all countries, signature status reduced emissions by around 3 tons of per capita CO_2, and in non-OECD countries, these reductions amount to around 2.5 tons. For OECD countries, there was no statistically significant effect of the Kyoto Protocol, although the coefficients are negative and smaller as compared to the other groups.[7] This would imply that those countries that politically insist most vividly on furthering hard law emission reduction target do not yet generate relative emission reductions due to international policies – whereas those countries which have taken over mostly informational obligations actually reduce relative emissions (c.p.). While we have presented our results in terms of partial derivatives, this result may constitute a puzzle. Perhaps treaty effects mask other factors which we have not yet included in our analysis or perhaps we have arrived at a paradox.

[7] As OPEC countries did not sign the Kyoto Protocol, they were excluded from this analysis.

Regarding the economic variables, the immediate effect of an increase of per capita income on CO_2 emissions per capita is positive (captured by GDP per capita growth in absolute terms) as expected. This is the case in all models, although the effect is substantially stronger in industrialized countries, where an increase of a hundred dollars in income between two periods leads to 2.5 tons in additional CO_2 emissions per capita.

The long term effects of income are more interesting: while they are positive on aggregate and in the developing countries, they are negative in OECD member states – albeit insignificantly so. Thus, ceteris paribus, an additional $100 leads more than 100 additional kilograms of CO_2 per capita in developing countries, whereas there is no significant long-term impact of income in industrialized countries. For industrialized countries, we may be at the verge of declining relative carbon emissions as the economy grows.

The second major set of economic variables is trade-related, as we consider the impact of trade openness (imports plus exports as a ratio of GDP). Again, we differentiate between the long and the short-term effects of an increase of the independent variable. The short-term impact of trade openness (changes in trade openness between two years) is uniformly positive and significant (except in Model 4b with OPEC countries), although stronger in OECD countries. That is, short-term effects of globalization in trade always increase per-capita CO2 emissions. This is not surprising in so far that trade is a vector of growth in economic activity.

More interesting are the long-run effects: Scholars have often questioned whether trade favors a 'pollution heaven' effect, that is, a shift of 'dirty' production to poorer countries. In fact, we find that the long term effects are generally not significant and close to zero, except in OPEC countries. In the latter countries, trade openness in the long run tends to decrease per capita carbon emissions: a percentage point increase in trade openness results in a decrease of .2 tons of CO_2 per capita.

Further, our results show that there are neither short-term nor long-term emission-reducing effects due to the transformation of economies from the primary and secondary sectors to a service economy – with the exception of OPEC countries, where short-term increases in the share of the service sector leads to higher emissions.

Finally, the price of oil has no immediate impact on per-capita carbon emissions, possibly due to the impossibility to adapt a country's emissions to short term changes in fuel prices. However, oil prices have a long run effect in both OECD and OPEC countries. In the former, higher oil prices tend to lead to a decrease in carbon emissions, which seems to indicate that industrialized economies adapt to shifts in fuel prices. On the other hand – and not surprisingly – OPEC countries see their carbon emissions respond positively to oil price increases.

5. Conclusion

The results of our exploratory analysis are striking: Political variables already display pronounced effects on *past* per capita carbon trajectories. This could also be interpreted as grounds for cautious optimism as political factors can be helpful in the transition to a low-greenhouse gas future.

In future analyses, we ideally would like to lengthen the time horizon to the period following WW II, include the economies in transition which have been omitted due to interrupted GDP time series, and use our generic research design in the context of other environmental issues. Furthermore, we would like to learn why some countries select themselves into different pollution trajectories than other countries.

Table 1: Description of Variables

Variable	N	Mean	Std.Dev.	Min	Max
CO2 per cap.	5045	3.606244	5.877655	0	55.5
Political Capacity	5106	0.9660341	0.4758995	0.01	7.4
Political Constraint	4715	0.31547	0.3340533	0	0.8935905
Democracy Level	5706	0.7928496	7.623378	-10	10
FCCC Signature	6549	0.2667583	0.4422987	0	1
Kyoto Signature	6549	0.0067186	0.0816974	0	1
GDP per Capita (K$)	5293	6.89451	8.038442	0.17055	84.69463
Trade Openness	5293	62.13518	50.34635	3.38	986.45
Service Sector	4032	0.6680311	0.1419842	0.0422223	0.9856503
Oil Price ($2007)	6438	30.96315	21.67004	9.651194	93.07938
OPEC*Trade Openness	5293	5.741217	21.95882	0	188.62
OPEC	6549	0.0761948	0.2653299	0	1

Table 2: Analysis of Carbon Emissions (1970-2004) – Differences

Dependent variable: Δ CO_2 per capita	(1a) All countries	(1b) All countries	(2a) OECD countries	(2b) OECD countries
Political Capacity (t-1)	-0.010 (0.029)	-0.020 (0.0237)	-0.089** (0.0423)	-0.089** (0.0413)
Political Constraint (t-1)	-0.189*** (0.0647)		0.066 (0.0996)	
Democracy Level (t-1)		-0.007*** (0.00191)		0.002 (0.00352)
FCCC Signature (t-1)	-0.038 (0.0269)	-0.037 (0.0239)	-0.033 (0.0628)	-0.037 (0.0656)
Kyoto Signature (t-1)	-0.104** (0.0479)	-0.118*** (0.0416)	-0.012 (0.0706)	-0.008 (0.0811)
GDP per Capita (t-1) (K$)	0.0326*** (0.00861)	0.0327*** (0.00761)	-0.0079 (0.00589)	-0.00734 (0.00546)
Δ GDP per Capita (K$)	0.127** (0.0536)	0.0878** (0.0445)	0.295*** (0.0511)	0.295*** (0.0525)
Trade Openness (t-1)	0.0000381 (0.000222)	0.00000893 (0.000275)	-0.000772 (0.000679)	-0.000731 (0.000671)
Δ Trade Openness	0.00693*** (0.00179)	0.00238*** (0.000682)	0.0188** (0.00749)	0.0191** (0.00765)
Service (t-1)	-0.0265 (0.0967)	-0.0362 (0.0986)	0.415 (0.316)	0.393 (0.305)
Δ Service	0.433 (0.318)	0.600** (0.286)	3.859 (2.38)	3.755 (2.364)
Oil Price (t-1)	-0.000478 (0.000808)	-0.000523 (0.00072)	-0.00392*** (0.00136)	-0.00392*** (0.00144)
Δ Oil Price	-0.000158 (0.00127)	0.000424 (0.00112)	-0.000931 (0.00216)	-0.00096 (0.00229)
OPEC * Trade Openness (t-1)	0.00175 (0.00171)	0.0011 (0.00153)	n.a	n.a.
OPEC (t-1)	0.0655 (0.0714)	0.073 (0.0674)	n.a.	n.a.
CO_2 per Capita (t-1)	-0.0364*** (0.011)	-0.0382*** (0.01)	-0.0118** (0.00543)	-0.0111* (0.00585)
Constant	0.0223 (0.0704)	-0.00365 (0.0637)	0.0815 (0.215)	0.111 0.193)
Observations	3558	3583	778	782
R^2	0.071	0.062	0.159	0.159

OLS regression with panel corrected standard errors (PCSE) (in parenthesis). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable: Δ CO2 per capita	(3a) Non-OECD	(3b) Non-OECD	(4a) OPEC	(4b) OPEC
Political Capacity (t-1)	0.005 (0.0335)	-0.005 (0.0278)	-0.019 (0.189)	-0.057 (0.175)
Political Constraint (t-1)	-0.119* (0.0625)		-0.212 (0.296)	
Democracy Level (t-1)		-0.004*** (0.00126)		-0.015* (0.00763)
FCCC Signature (t-1)	0.007 (0.0284)	0.008 (0.0181)	0.217 (0.15)	0.281** (0.136)
Kyoto Signature (t-1)	-0.130* (0.0762)	-0.150** (0.0698)	n.a. n.a.	n.a. n.a.
GDP per Capita (t-1) (K$)	0.0614*** (0.0139)	0.0609*** (0.0118)	0.0928*** (0.0226)	0.0931*** (0.024)
Δ GDP per Capita (K$)	0.147*** (0.0559)	0.104** (0.0468)	0.201*** (0.0644)	0.156** (0.0791)
Trade Openness (t-1)	-0.00043 (0.000328)	-0.000422 (0.000391)	-0.0181*** (0.00495)	-0.0173*** (0.0049)
Δ Trade Openness	0.00616*** (0.00183)	0.00153** (0.000759)	0.0329*** (0.00751)	0.0047 (0.00418)
Service (t-1)	-0.159 (0.109)	-0.159 (0.103)	0.308 (0.592)	0.0545 (0.55)
Δ Service	0.295 (0.32)	0.485* (0.269)	6.690* (3.917)	9.485*** (3.451)
Oil Price (t-1)	0.00103 (0.000832)	0.000977 (0.000595)	0.0119* (0.00611)	0.0122* (0.00653)
Δ Oil Price	-0.000371 (0.0013)	0.000338 (0.00088)	-0.00428 (0.00926)	0.000832 (0.00925)
OPEC * Trade Openness (t-1)	-0.00103 (0.00165)	-0.00159 (0.00153)	0.0134*** (0.00446)	0.0107** (0.00422)
OPEC (t-1)	0.169** (0.078)	0.176** (0.078)	-0.670** (0.34)	-0.581* (0.325)
CO2 per Capita (t-1)	-0.0540*** (0.0157)	-0.0557*** (0.0137)	-0.0830*** (0.0249)	-0.0834*** (0.0275)
Constant	-0.0317 (0.0789)	-0.0453 (0.0681)	0.133 (0.53)	0.253 (0.451)
Observations	2780	2801	393	394
R^2	0.107	0.103	0.19	0.171

OLS regression with panel corrected standard errors (PCSE) (in parenthesis). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Analysis of Carbon Emissions (1970-2004) – Levels (select variables only)

Level effects on CO2 per capita	(1a) All countries	(1b) All countries	(2a) OECD countries	(2b) OECD countries	(3a) Non-OECD	(3b) Non-OECD	(4a) OPEC	(4b) OPEC
Political Capacity (t-1)	-0.275	-0.524	-7.542**	-8.018**	0.093	-0.090	-0.229	-0.683
	(0.797)	(0.620)	(3.585)	(3.721)	(0.620)	(0.499)	(2.277)	(2.098)
Political Constraint (t-1)	-5.192***		5.593		-2.204*		-2.554	
	(1.777)		(8.441)		(1.157)		(3.566)	
Democracy Level (t-1)		-0.183***		0.180		-0.072***		-0.180*
		(0.050)		(0.317)		(0.023)		(0.091)
FCCC Signature (t-1)	-1.044	-0.969	-2.797	-3.333	0.130	0.144	2.614	3.369**
	(0.739)	(0.626)	(5.322)	(5.910)	(0.526)	(0.325)	(1.807)	(1.631)
Kyoto Signature (t-1)	-2.857**	-3.089***	-1.017	-0.721	-2.407*	-2.693**	n.a.	n.a.
	(1.316)	(1.089)	(5.983)	(7.306)	(1.411)	(1.253)		
GDP per Capita (t-1) (K$)	0.896***	0.856***	-0.669	-0.661	1.137***	1.093***	1.118***	1.116***
	(0.237)	(0.199)	(0.499)	(0.492)	(0.257)	(0.212)	(0.272)	(0.288)
Δ GDP per Capita (K$)	3.489**	2.298**	25***	26.577***	2.722***	1.867**	2.422***	1.871**
	(1.473)	(1.165)	(4.331)	(4.730)	(1.035)	(0.840)	(0.776)	(0.948)
Trade Openness (t-1)	0.001	0.000	-0.065	-0.066	-0.008	-0.008	-0.218***	-0.207***
	(0.006)	(0.007)	(0.058)	(0.060)	(0.006)	(0.007)	(0.060)	(0.059)
Δ Trade Openness	0.190***	0.062***	1.593**	1.721**	0.114***	0.027**	0.396***	0.056
	(0.049)	(0.018)	(0.635)	(0.689)	(0.034)	(0.014)	(0.090)	(0.050)

Appendix: Data Sources

CO2 per capita:	Climate Analysis Indicators Tool (CAIT), Version 6.0. (Washington, DC: World Resources Institute, 2009).
RPC:	Relative Political Capacity Index. Data from Jacek Kugler. ontact information: http://www.cgu.edu/pages/477.asp (accessed 15 Nov. 2008).
PolCon V:	Political Constraints Index 2006 Release (with data to 2004). Data from Witold Henisz. Available at: http://www-management.wharton.upenn.edu/henisz/ (accessed 15 Nov. 2008).
Polity IV:	Polity IV Annual Time-Series 1800-2007. Available at: http://www.systemicpeace.org/inscr/p4v2007.xls (accessed 14 Feb. 2009).
FCCC signature status:	United Nations Framework Convention on Climate Change: Status of Ratification (as of 22 August 2007), UNFCC. Available at: http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf (accessed 04 Feb. 2009).
Kyoto Protocol sig, status::	Kyoto Protocol Status of Ratification (as of 14 January 2009). UNFCCC. Available at: http://unfccc.int/files/kyoto_protocol/status_of_ratification/application/pdf/kp_ratification.pdf (accessed 04 Feb. 2009).
Real GDP per capita:	Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006. http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php (accessed 15 Nov. 2008).
Trade Openness:	Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006. http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php (accessed 15 Nov. 2008).

Service Sector:	GDP and its breakdown at current prices in US Dollars, United Nations Statistics Division. Available at: http://unstats.un.org/unsd/snaama/dnllist.asp
OPEC:	Available at: http://www.opec.org/aboutus/ (accessed 15 Dec. 2008).
Oil Price:	BP Statistical Review of World Energy June 2008. Available at: http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/downloads/pdf/statistical_review_of_world_energy_full_review_2008.pdf (accessed 04 Feb. 2009).
Population:	Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006. http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php (accessed 15 Nov. 2008).

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